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FACTORS INFLUENCING THE DEMAND FOR RURAL DEPOSITS IN BANGLADESH: A TEST FOR FUNCTIONAL FORM

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ABSTRACT

This paper uses Bangladesh district data to determine the functional form of the demand for rural deposits through the Box-Cox transformation. The results show that the Box-Cox form generates better results than the linear and log-linear forms. Interest rates, branch density, a roads and vehicle index and income positively influence demand for interest bearing deposits. The results of simulation of deposits under different interest rate and branching policy scenarios showed that depositors are more sensitive to interest rate changes than to branch density.

BIOGRAPHICAL SKETCH

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INTRODUCTION

In recent years, there has been an upsurge of interest among policymakers, academicians and international agencies towards mobilization of rural savings in developing countries to improve the viability of rural financial institutions and to reduce their dependency on limited and volatile supplies of foreign aid. Traditionally, efforts to mobilize savings were limited to urban areas because of the assumption that poor rural people cannot save. The rural finance literature now amply documents that rural areas have savings that can be mobilized through financial intermediaries (e.g., Adams, 1978; Meyer, 1986; Von Pischke, 1978). There is even some evidence that the marginal propensity to save in rural areas is higher than in urban areas (Alamgir, 1974; Williamson, 1968).

Although financial institutions in Bangladesh were induced to expand rural operations in the 1970s to supply agricultural credit, the recent emphasis on savings mobilization has resulted in a large volume of rural deposits (Khalily, Meyer, and Hushak; Mridha). Little research has been conducted, however, on the factors determining the demand for rural deposits in developing countries. A few recent studies provide some information and suggest areas for further research

(Burkett and Vogel, 1987a; Srinivasan and Meyer; Vasquez). Most studies of demand for rural deposits in developing countries use a log-linear functional form (Burkett and Vogel, 1987a; Guerrero; Srinivasan and Meyer). This form is usually chosen, not because it is superior to non-linear forms, but because of statistical convenience and easier estimation of elasticities. If the incorrect functional form is chosen, however, the empirical results may be biased and inconsistent, and may lead to misspecification error (Kmenta; Murty and Murty; Zarembka). This paper shows that because of a lack of one-to-one correspondence between income, bank branches and deposits, the linear and log-linear forms are likely to be inappropriate.

Studies of rural deposits often do not treat interest rates and bank branches very satisfactorily. First, many studies use cross-sectional data because time series data are unavailable to test for the impact of changes in interest rates and bank branches. Second, interest rates are frequently inflexible at least in nominal terms. Third, bank branches cannot be continously expanded since deposit potential is limited in any given area, but some simulation technique must be used to determine how increased branches may stimulate deposits by lowering transaction costs.

The objectives of this paper are three fold: First, to analyze the factors influencing demand for rural deposits in Bangladesh; Second, to present and evaluate the effects of simulated interest rates and bank branches on rural deposits; Third, to test for functional forms of demand for rural deposits using Box-Cox parametric transformation (see Box and Cox for a detailed discussion).

Zarembka argues that the Box-Cox transformation has the advantage of determining the most appropriate functional form by maximizing the likelihood function. It allows for linear and log-linear functional forms, but has the advantage of being simpler to estimate.

Simulations were conducted in this research in order to test the impact of changes in interest rates and bank branches, and to illustrate the differences in predicted changes in deposits determined from different functional forms. Three policy scenarios were introduced: (i) a change in interest rates; (ii) a change in bank branches; and (iii) a simultaneous change in bank branches and interest rates. All the policy changes were simulated at 5 and 10 percent levels.

THE DEMAND FOR RURAL DEPOSITS FUNCTION

Similar to other demand functions, the household demand for rural deposits function can be expressed as:

$$D_i = f(P_{oi}, DIR, Y) \qquad (1)$$

where D_i refers to interest-bearing deposits, Y is income, and DIR and P_{oi} represent price of deposits, and prices of other substitutes and complementary goods, respectively. The demand function is specified in the form suggested by Santomero, and Burkett and Vogel (1987b) in which the household portfolio decision to mazimize net revenues (gross revenue less transaction costs) contains both cash management and investment elements.

The interest rate paid on deposits is the explicit price. The real price is the explicit price less transaction costs. Because of the unavailability of transaction

costs data, most authors must use proxies such as number of bank branches or an index for roads and vehicles (Burkett and Vogel, 1987b; Khalily, Meyer and Hushak; Srinivasan and Meyer). Several studies have found a positive relationship between deposit rates and interest bearing deposits, but a debate exists over the effects of changes in interest rates. Lanyi and Saracoglu, evaluating evidence from Asian countries, suggested that the income effect of interest rate changes is more important than the substitution effects.

Physical assets and other forms of financial instruments represent competing goods. Ortmeyer found that a higher return earned on physical assets contributes negatively to the household demand for financial assets. Similarly, Gupta found deposits to be substitutes for government financial instruments. But due to the lack of organized data on returns to rural investments, most studies of demand for deposits exclude the prices of other commodities thereby creating a problem for tests for homogeneity and symmetry conditions.

Income has a profound influence on interest bearing deposits. The higher the income of rural households, the greater will be their ability to demand interest bearing deposits. Because of the variability expected in rural household income, the permanent income hypothesis may offer a better explanation of the influence of income than does the "absolute income" hypothesis. In this paper, permanent income is tested. The coefficient of transitory income is expected to be larger than the coefficient for the permanent income variable.

Considering the above, the demand function for rural deposits is redefined as:

$$D_i = f\,(BBR, DIR, RTI, PY, TY) \qquad (2)$$

where BBR and DIR are number of rural bank branches and weighted interest rates, respectively. RTI is the index of roads and vehicles, and PY and TY represent permanent and transitory income, respectively.

Considering a general functional form as defined by Box-Cox, and applied by Zarembka, eq. (2) can be expressed as:

$$\frac{D(t)^{\lambda}-1}{\lambda} = \beta_o + \beta_1 \frac{BBR(t)^{\lambda}-1}{\lambda} + \beta_2 \frac{DIR(t)^{\lambda}-1}{\lambda} + \beta_3 \frac{RTI(t)^{\lambda}-1}{\lambda} + \beta_4 \frac{PY(t)^{\lambda}-1}{\lambda} + \beta_5 \frac{TY(t)^{\lambda}-1}{\lambda} + \epsilon_t \qquad (3)$$

where, ϵ_t is the disturbance term, and β_o, β_1, β_2, β_3, β_4 and β_5 are the parameters. The objective is to find a value of λ such that the likelihood function is maximized. Box-Cox showed that for a given λ, the maximum log likelihood value is:

$$L_{max}\,(\lambda) = -\frac{T}{2} \log \sigma^2\,(\lambda) + (\lambda - 1) \sum_t \log D_i(t) \qquad (4)$$

The confidence region of λ can be estimated by using the maximum likelihood ratio, which is $L_{max}\,(\hat{\lambda}) - L_{max}\,(\lambda) \leq \frac{1}{2} X^2(\alpha)$. When $\lambda=0$ and $\lambda=1$ fall within the confidence interval, the function is, respectively, log-linear and linear.

There are no empirical studies or comprehensive theoretical discussion about the possible trends in deposit elasticities for an expansion in bank branches,

interest rates, roads and vehicle index and income. It is unlikely that there is a one-to-one correspondence between demand for deposits and these explanatory variables. It should be expected that income will influence demand for rural deposits because high income households probably enjoy better investment opportunities in nonfinancial assets than do low income ones. Therefore, their marginal demand for deposits as income rises will probably be less than for poorer households. Similarly, because of limited deposit potential in any geographic area, a continuous expansion of banking facilities will eventually lead to a decrease in deposits per branch. The nature of the effects of interest rates and the roads and vehicle index cannot be determined a priori since they are linked to alternate forms of investments and wider investment opportunities. They depend on income and substitution effects related to returns generated on alternate forms of investments and related transaction costs. For these reasons, no prior sign is attached to β_2 and β_3 but β_1, β_4 and β_5 are expected to be greater than zero.

DATA SOURCES

The model was fitted to pooled district data for 1983 and 1984. Data on income, interest rates, roads and vehicles were obtained from the Bangladesh Statistical Year Book, 1985. Data on deposits and rural bank branches were obtained from the Central Bank Data Tapes. Deposits are defined as district level interest-bearing deposits. Income was proxied by district agricultural GDP. The permanent and transitory components of agricultural GDP were estimated from 1976-84 GDP data by regressing GDP on time. Trend values were treated

as permanent agricultural GDP. Interest rates offered on various types and classes of deposits are the same across districts. Therefore, a weighted deposit interest rate (DIR) was calculated by weighting the proportion of each type of deposit to total deposits in each district. Bank branches were measured as number of branches per 10,000 rural inhabitants. The index of district roads and vehicles was constructed as:

$$RD_j = \frac{R_j}{TA_j} \div \frac{POP_j}{T_J} \qquad (5)$$

where RD_j is the weighted index of roads and vehicles in the j^{th} district; R_j is the mileage of roads in the j^{th} district; TA_j is the total district geographic area; and T_j is the number of vehicles registered in the district. POP_j refers to population of the jth district. The index measures mileage of roads adjusted for area weighted by population per vehicle in each district.

EMPIRICAL RESULTS AND ANALYSIS

Since the Box-Cox transformation was conducted for both the dependent and independent variables by the same λ values, the transformation allows for testing of only linear and log-linear functions. The R^2 and the log-likelihood function were maximized at $\lambda = -0.53$. Therefore, the variables were transformed by the λ value of -0.53 and the estimates of the parameters were obtained by ordinary least squares. The Goldfeld-Quandt technique was used to test for hetero-skedasticity. Heteroskedasticity was rejected.

Table 1 shows the estimated regression coefficients under the different values λ = -0.53, λ = 0 (log-linear case), and λ = 1 (linear case). The coefficients have the expected signs in all cases, although the R^2 for the Box-Cox form and the log-linear is larger than for the linear form. The R-square for the Box-Cox was estimated at 0.818, while it was 0.766 for the log-linear function.

The results presented in Table 1 show that all coefficients have the expected sign in all three functions. There are important differences, however, in the significance of specific variables. All variables are significant at the 5 percent level in the Box-Cox form. Permanent income (PY) is not significant in the linear case, and interest rate (DIR) is not significant in either the linear or the log-linear forms. Therefore, by comparing the standard error and the number of significant variables, the Box-Cox form is clearly superior. The statistical significance of differences among functional forms was tested. By using the likelihood ratio, the 95% confidence interval for λ was estimated. λ varies between -.95 and -.15. Since $\lambda=1$ and $\lambda=0$ do not fall within this range, the null hypotheses of the log-linear and linear functional forms are rejected.

The Box-Cox results in table 1 confirm expectations about the factors affecting rural deposits. The significant coefficient for bank branches and the roads and vehicle index imply that an increase in branches and roads and vehicles increases demand for interest bearing deposits by reducing depositor transaction costs and by providing depositors with a secure place for savings. A significant interest rate coefficient suggests that rural depositors demand more deposits with

an increase in interest rates. This implies that an increase in interest rates, all other things being equal, has an income effect. The permanent income hypothesis is supported since the transitory income coefficient is larger than the permanent income coefficient. This implies that rural households use deposits to offset income fluctuations and/or to meet unexpected contingencies.

Policy makers, in the short run, have potentially greatest control over interest rates and bank branches. To test for the impact on deposits of changes in these two variables, increases of 5 and 10 percent were simulated. This involved estimating new marginal coefficients for these variables and the level of predicted deposits. In the Box-Cox form, the simulation produced an increasing trend in the size of the marginal coefficients, while they decreased in the linear form, and were constant in the log-linear form.

The differences in simulated predicted deposits for the three functional forms are presented in table 2. The Box-Cox results show that a 5 percent increase in interest rates leads to an increase in rural deposits by 24.1 million taka, an increase of over 5.9 percent. The same percentage increase in bank branches increases deposits by 14.8 million taka, an increase of over 5.2 percent from the base. A similar pattern is observed when interest rates and brank branches were increased by 10 percent. This suggests that depositors are more sensitive to changes in interest rates than to bank branches over this range of simulations. The result may be different in relatively "unbanked" areas, however, where the lack of branches creates high depositor transaction costs. This would imply

disaggregating the regions into banked and unbanked areas, a task difficult to undertake because of the way the data are compiled. The simultaneous simulation of interest rates and bank branches showed that the effects are independent and additive. The total effects of these changes on predicted deposits are higher in the Box-Cox transformation than in the log and linear functional forms.

The prediction error is large in both the linear and log forms relative to the Box-Cox: predicted deposits with the linear model range from 10 to 40 percent of the Box-Cox, while the log model resulted in predictions 60 to 70 percent of the Box-Cox. These results suggest that prediction from a misspecified functional form can generate a substantial error. Policy makers and bankers in Bangladesh would have reason to be much less optimistic about rural deposit mobilization than they should be if they used a linear or log-linear model rather than the Box-Cox for predicting depositor response to changes in interest rates and bank branches.

CONCLUSIONS

The regression results obtained with the model satisfactorily explain the expected relationship between rural bank deposits and the several independent variables tested. The results support other research that has argued that interest rates and transaction costs are important in explaining demand for rural deposits.

Four major findings emerge from this study. First, both the linear and log-linear forms of the demand for deposits functions were rejected. Second, deposit elasticities and marginal coefficients increased with the simulated changes in

interest rates and bank branches. Third, depositors are induced to demand relatively more deposits through an increase in interest rates than through the proportionally same expansion of bank branches. This may imply that with given transaction cost levels, a higher interest rate will have an income effect. Fourth, both the log and linear functional forms underestimate by a wide margin the predicted change in deposits associated with changes in interest rates and bank branches. This suggests that a misspecified function may lead banks to adopt an overly conservative expectation of the impact of interest rate and branching policies. Therefore, the choice of functional form must be carefully reviewed in studies of rural deposit behavior in developing countries in order to avoid biased and inconsistent results which may imply large social costs through inappropriate policy formation.

The central bank, as the simulations suggest, through appropriate branching and interest rate policies can stimulate increased deposit mobilization and provide better returns to depositors. However, given the limited deposit potential in any geographic area, the central bank must avoid licensing too many branches for each market so that banks suffer large financial losses through small size operations. The administrative costs of branching must be balanced against the benefits received by depositors through reduced transaction costs. That is a subject requiring additional research in Bangladesh.

TABLE 1

Estimates of Parameters Under Different Functional Forms

Model	Independent Variable BBR	DIR	RTI	PY	TY	R^2
λ =-.53	.1048*	.3845**	0.0039*	.01835*	.3229*	.818
	(.01089)	(.2869)	(.000759)	(.01007)	(.1020)	
λ = 0	1.4273*	.8345	0.2067*	.1932**	.3701*	.766
	(.19401)	(.9318)	(.0402)	(.1405)	(1.1003)	
λ = 1	185.26*	1.2789	66.711*	26.357	411.61*	.509
	(57.865)	(13.121)	(22.715)	(27.052)	(152.91)	

Note: Figures in parenthesis represent standard errors.
* Significant at .05 level
** Significant at .10 level

TABLE 2

Simulation of Deposits Under Different Policy Scenarios[a]

Functional Form	Interest Rate Increase		Bank Branch Increase		Combined Effects	
	5%	10%	5%	10%	5%	10%
Box-Cox (λ=-.53)	24.1	50.1	14.8	29.9	38.9	80.8
Log-Linear (λ=0)	15.0	31.2	10.1	20.4	25.1	52.1
Linear (λ=1)	2.8	5.9	5.5	11.1	8.2	17.1

[a] Simulated deposits are in million taka

REFERENCES

Adams, Dale W, 1978, "Mobilizing Household Savings through Financial Markets," Economic Development and Cultural Change, Vol. 26, pp. 547-570.

Alamgir, Mohiuddin, 1974, "Some Analysis of Distribution of Income, Consumption, Saving and Poverty in Bangladesh," The Bangladesh Development Studies, Vol. II, pp. 737-818.

Box, G. E. P., and D. R. Cox, 1964, "An Analysis of Transformations", Journal of the Royal Statistical Society, Vol. 26, No. 2.

Burkett, P. and R. C. Vogel, 1987a, Statistical Analysis of Factors Promoting Successful Deposit Mobilization in Peru, (mimeo.), Department of Economics, University of Miami.

Burkett, P. and R. C. Vogel, 1987b," Microeconomic Foundations of Financial Liberalization: Interest Rates, Transaction Costs, and Financial Savings", in Economic Reform and Stabilization in Latin America, Michael Connoly and Claudio Gonzalez-Vega (eds.), N.Y.: Praeger.

Guerrero, J. A., 1988, "Determinants of Successful Rural Deposit Mobilization: Banco Agricola in the Dominican Republic," Unpublished M.S. Thesis, The Ohio State University, Columbus.

Gupta, K. L., 1970, "Household Savings in Financial Assets - A Case Study of India", Indian Economic Journal, Vol. 17, No. 3, pp. 500-514.

Khalily, M. A. Baqui, R. L. Meyer and Leroy Hushak, 1987, "Deposit Mobilization in Bangladesh: Implications for Rural Financial Institutions and Financial Policies," The Bangladesh Development Studies, Vol. 15, pp. 85-117.

Kmenta, Jan, 1986, Elements of Econometrics, 2nd Edition, Macmillan Publishing Company, N.Y.

Lanyi, A. and R. Saracoglu, 1983, "Interest Rate Policies in Developing Countries", Occasional Staff Paper No. 22, International Monetary Fund, Washington D.C.

Meyer, R. L., 1986, "Deposit Mobilization for Rural Lending", in Report of the Third Technical Consultation on the Scheme for Agricultural Credit Development, FAO, Rome.

Mridha, A. T. M. I., 1984, "Rural Savings Mobilization in Bangladesh", paper presented at the Workshop on Rural Savings Mobilization, APRACA, Manila, October 3-5.

Murty, G. V. S. N. and Sukumari Murty, 1978, "The Functional Form of the Demand for Money in Bangladesh", The Bangladesh Development Studies, Vol. 6, Autumn, pp. 443-459.

Ortmeyer, D. L., 1985, "A Portfolio Model of Korean Household Saving Behavior, 1962-76", Economic Development and Cultural Change, Vol. 33, No. 3, pp. 575-599.

Santomero, A. M., 1979, "The Role of Transaction Costs and Rates of Return on the Demand Deposit Decision," Journal of Monetary Economics, Vol. 5, pp. 343-364.

Srinivasan, A. and R. L. Meyer, 1986, "An Empirical Analysis of Rural Deposit Mobilization in South Asia, ESO No. 1249, Department of Agricultural Economics and Rural Sociology, The Ohio State University, Columbus.

Vasquez, A. L., 1986, "Determinants of Household Deposit Behavior in the Dominican Republic," Unpublished M.S. Thesis, The Ohio State University.

Von Pischke, J. D., 1987, "Towards on Operational Approach to Savings for Rural Development," Savings and Development, Vol 2: pp. 43-57.

Williamson, J. G., 1968, "Personal Savings in Developing Nations: An Intertemporal Cross-Section From Asia," Economic Record, Vol. 44, pp. 194-210.

Zarembka, P., 1968, "Functional Form in the Demand for Money", Journal of the American Statistical Association, Vol. 63 No.322, June 1968, pp. 502-511.